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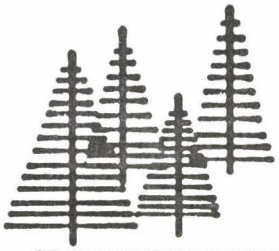
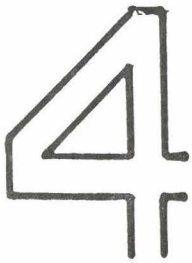


FOREST PEST MANAGEMENT

3420
Report No. 91-1
January 1990

STATE & PRIVATE FORESTRY



INTERMOUNTAIN REGION

Western Spruce Budworm Silvicultural Demonstration Area, Payette National Forest

By

Julie C. Weatherby[1]
and
Donn B. Cahill[2]

ABSTRACT

A project designed to evaluate and demonstrate effects of several silvicultural strategies on western spruce budworm populations and resource outputs during and subsequent to an ongoing outbreak was conducted on the Payette National Forest, Idaho. After treatment, larval populations were reduced in units which retained less than 70 ft^2 of basal area in grand fir. Growth rates for each tree species measured 10 years prior to treatment and 5 years after treatment remained stable. Only ponderosa pine showed a consistent growth increase after treatment.

[1] Entomologist, Intermountain Region, Forest Pest Management, Boise, Idaho.
[2] Entomologist (retired), Intermountain Region, Forest Pest Management, Boise, Idaho.

INTRODUCTION

The western spruce budworm (WSBW), *Choristoneura occidentalis* Freeman, a native insect species, is the most widely distributed and destructive defoliator of coniferous forests in western North America (Fellin and Dewey 1982). WSBW feeds principally in buds (vegetative and reproductive) and on current-year foliage of Douglas-fir, grand fir, and subalpine fir. Several consecutive years of heavy feeding on individual trees can cause nearly complete defoliation and result in appreciable growth loss, tree deformity, topkilling, and tree mortality.

The WSBW has a wide ecological amplitude. It is common from warm, dry Douglas-fir (*Pseudotsuga menziesii* var. *glauca* (Beissn.) Franco) habitat types found at low elevations to the cool, moist subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.) habitat types at high elevations. Stand susceptibility to WSBW is affected by the interaction of site and stand factors, such as species composition, stand density, height-class structure (tree height variability), vigor, maturity, site climate, regional climate, and degree of isolation from other susceptible stands. Susceptible stands are composed primarily of shade-tolerant conifers, very densely stocked, low in vigor, multi-storied, physiologically mature, and are on warm, dry sites characterized as having relatively warm, dry regional climates (Wulf and Cates 1987). Carlson et al. (1987) believe that "prescribed silvicultural treatment can reduce stand and forest susceptibility to western spruce budworm."

This report describes a project on the Payette National Forest designed to evaluate and demonstrate effects of several silvicultural strategies on WSBW populations and resource outputs during and subsequent to an ongoing outbreak.

DESCRIPTION OF PROJECT AREA

The project area is located within or adjacent to the Brundage Mountain Timber Sale (T. 18 N., R. 2 E., sec. 36) on the McCall Ranger District, Payette National Forest. The project area includes sale units 4, 5, 14, and 26 in compartment 32 and a control area (Figure 1).

The area is situated on gently rolling terrain with slopes ranging from 10 to 25 percent. The elevation is 5,400 to 5,600 ft, and the major habitat type is *Abies grandis/Vaccinum globulare*. The stands are composed principally of grand fir and Douglas-fir. Minor amounts of Engelmann spruce (*Picea engelmannii*), western larch (*Larix occidentalis*), ponderosa pine (*Pinus ponderosa*), and lodgepole pine (*Pinus contorta*) are also present.

Prior to treatment, the stands were generally composed of three recognizable canopy levels which varied considerably in stocking density and composition. The overstory was often sporadic and was composed of mature and overmature Douglas-fir, grand fir, and some remnant ponderosa pine. A layer of 60- to 80- year-old grand fir poletimber dominated stocking in unit 4 and occurred elsewhere in patches. Seedlings and saplings tended to be sparsely distributed in openings, but dense clumps of grand fir were associated with closed overwood canopies.

RECENT WSBW HISTORY IN PROJECT AREA

The latest WSBW outbreak on the Payette NF began in the late 1960's. Aerial detection information indicated that WSBW had been active within the Brundage Mountain Timber Sale area since

1970—14 years prior to the installation of this demonstration project. The WSBW has been one of the most debilitating agents in these stands. Following the 1980 growing season, some pole-sized grand fir appeared completely defoliated, attesting to the chronic nature of the outbreak. Some seedling and sapling mortality was also observed.

METHODS

Treatments. Five treatments were imposed in 1984: 1) commercial thin/improvement cut to retain poletimber and small sawlog size trees—unit 4; 2) seed tree cut with limited under planting—unit 5; 3) seed tree step of a shelterwood cut—unit 14; 4) clear-cut and plant—unit 26; and 5) no cut—control area. Stand and entomological information were collected prior to and following treatment as described below. Descriptions of pre-treatment and post-treatment stand composition, stocking levels, WSBW population levels, and defoliation estimates for each treatment unit are included in the results and discussion sections of this report.

Stand Sampling Procedures. Stand examinations were conducted in all units except the control unit prior to harvest in May 1984. Stand examinations were completed in May 1985 in the control unit. General site data which were recorded for each treatment unit included: average percent slope, aspect, elevation, physiographic site, soil characteristics, and predominant ground cover vegetation. Ten permanent stand examination plots within each treatment unit were established. Stand examination plots consisted of a variable radius plot (BAF 20) for tallying trees $\geq$ 5.0 in d.b.h. and a fixed-radius plot (1/100 acre) for tallying trees < 5.0 in d.b.h. Data recorded for all tally trees during the pre-treatment examination included: species, d.b.h., height, identification and intensity of damaging agents, live crown ratio, crown class or position, and tree history. Tree age was determined for a representative sample of conifers in all crown positions. Ten-year radial increments were measured on a subsample of conifers which were $\geq$ 3.0 in d.b.h. and had been stratified by species and 2.0-in diameter classes.

These plots were revisited in July 1989, 5 years following treatment. All stand measurements with the exception of age were remeasured.

Entomological Sampling Procedures. In July 1983, pre-treatment WSBW population and defoliation data were collected from each of the treatment units. Five temporary plots were established in each unit and two host trees with diameters exceeding 5 in and heights within a 20 to 70 ft range were sampled within each plot. Sampling included ocular estimates of entire tree defoliation and branch sampling for larvae and pupae.

An ocular estimate of percent defoliation of the current foliage throughout the crown was made for each sample tree, and this estimate was grouped into the following defoliation classes:

0 = no defoliation
1 = 1 to 25 percent defoliated
2 = 26 to 50 percent defoliated
3 = 51 to 75 percent defoliated
4 = 76 to 99 percent defoliated
5 = 100 percent defoliated

On each sample tree (10 sample trees per treatment unit), two 18-in branches were cut from opposite sides of the midcrown using a pole pruner equipped with a collecting bag. If a sample branch had fewer than 15 live buds, a new branch was selected. Larvae were removed from the branches in

the field by beating the branch with a stick over a white drop cloth. Branches were examined for the presence of pupae and to make sure that all larvae had been dislodged from the foliage. The total number of budworm larvae and pupae and the number of current buds were recorded for each sample branch.

The project area was revisited in August 1985. In each treatment unit, post-treatment defoliation estimates were recorded for 30 sample trees using the previously described classification procedure. Thirteen trees were sampled in the control unit. Population and defoliation sampling was not attempted in the clear-cut unit.

In September 1986, defoliation classes were recorded for the host trees located in the permanent stand examination plots established in 1984. No population estimates were recorded.

In June 1987 and 1988 and in July 1989, units 4, 5, 14, and the control unit were revisited. During each year, WSBW populations were sampled from 50 randomly selected trees in each unit. Previously described population sampling techniques were utilized for each sample tree. No defoliation sampling was attempted during 1987, 1988, or 1989 due to the WSBW population collapse and lack of visible defoliation.

RESULTS

Pre- and post-treatment stand composition and stocking information along with the pre- and post-treatment budworm population and defoliation information are discussed by treatment area.

Commercial Thin/Improvement Cut. A commercial thin/improvement cut was carried out on 15 acres in unit 4. Prior to thinning, the stand was stocked with 306 trees $\geq$ 5 in d.b.h. and 20 trees < 5 in d.b.h. per acre (Table 1). During the thinning operation, scattered old-growth sawtimber was removed, and the remaining stand was thinned from below to retain poletimber and small sawtimber crop trees. The thinning from below was largely precommercial in nature, with suppressed seedlings and saplings being slashed. Slash was spot dozer piled and burned. Approximately 8.5 MBF of volume per acre were removed. About 82 ft^2 of basal area per acre composed of 88 percent grand fir, 10 percent Engelmann spruce, and 2 percent Douglas-fir were retained (Table 2). Projected stand management is for the initiation of a shelterwood regeneration system in about 20 years.

Pre-treatment larval sampling detected mean populations of 2.43, and 9.75 larvae per 1,000 in^2 of foliage on Douglas-fir and grand fir, respectively. The higher larval density on grand fir resulted in defoliation estimates which were 3 times higher than the estimates for Douglas-fir. Post-treatment defoliation estimates made in 1985 and 1986 indicate an increase in the intensity of defoliation (Table 6). Larval populations which were relatively high through June 1987 collapsed later that season and remained low in 1988 and 1989. Tables 4 and 5 summarize pre- and post-treatment larval densities.

Seed Tree Cut. A seed tree cut favoring ponderosa pine, Douglas-fir, western larch, and lastly grand fir was prescribed for 26 acres in unit 5. Pre-treatment stand parameters are summarized in Table 1. Within this unit, a few small clumps of immature sawtimber occurred, while advance regeneration of Douglas-fir and ponderosa pine was present on 20 percent of the area. The clumps of immature sawtimber were slashed and burned favoring an even-aged stand. The advance regeneration was retained for future crop trees. Approximately 12 MBF per acre were removed, leaving

approximately 3.5 MBF per acre. An average of 21 trees per acre were retained. Leave trees were predominantly Douglas-fir with diameters greater than 12 in. Site preparation was accomplished by dozer piling and burning. This area was underplanted at a rate of 160 Douglas-fir and 170 ponderosa pine seedlings per acre. Underplanting was accomplished in order to insure adequate regeneration of the area.

Pre-treatment population densities and defoliation estimates in unit 5 were very similar to those found in unit 4. Population densities averaged 3.45, 8.19, and 9.54 larvae per 1,000 in^2 of foliage on Douglas-fir, grand fir and spruce, respectively. Grand fir was more heavily defoliated than either Douglas-fir or spruce. This information is summarized in Tables 4 and 6. In comparison to larval population densities detected in the other treatment units, the 1987 post-treatment population in unit 5 was unusually low (mean = 0.46 larvae per 1,000 in^2 of foliage) and may not accurately reflect the real population. Larval populations during 1988 and 1989 remained low, averaging approximately 0.3 larvae per 1,000 in^2 of foliage.

Seed Step of Shelterwood Cut. In unit 14, 15 acres were harvested according to criteria established for a seed step of a shelterwood cut. Pre-treatment stand parameters are listed in Table 1. Approximately 7.3 MBF per acre were harvested from the area, leaving 40 thrifty, mature seed trees, primarily Douglas-fir and ponderosa pine, per acre. Slash was piled and burned.

Pre-treatment population densities and defoliation levels were similar to the mean densities and percent defoliation found in the other treatment areas. Larval populations averaged 10.38 larvae per 1,000 in^2 of foliage in 1983. By 1988, post-treatment larval populations had declined to insignificant levels. Tables 4 and 5 summarize this information.

Clear-cut and Plant. Unit 26 is a 13-acre unit which was scheduled to be clear-cut and planted. Pre-treatment stand examination data indicated that approximately 14.4 MBF of volume per acre was present before treatment. The stocking level for green trees $\geq$ 5 in d.b.h. was 179 trees per acre of which 80 percent were grand fir. An additional 530 trees per acre of advanced regeneration was present. In the fall of 1984, the unit was clear-cut and broadcast burned. Planting at a rate of 220 Douglas-fir, 110 western larch, and 100 ponderosa pine per acre was completed the following spring (1985). Tables 1, 2, and 3 developed from stand examination data summarize this information.

Both pre-treatment mean larval density and mean percent defoliation were higher on the grand fir than on Douglas-fir. Three times as many larvae were recovered on samples taken from grand fir (mean = 14.89 larvae per 1,000 in^2 of foliage) as compared to samples taken from Douglas-fir (mean = 5.39 larvae per 1,000 in^2 of foliage). The percent defoliation averaged 76.79 on grand fir and 12.50 on Douglas-fir. Tables 4 and 6 display this information. No post-treatment population estimates were obtained.

No-cut or Control. The no-cut or control unit is 10 acres in size and is located directly east of unit 26. Stocking averages about 180.7 trees $\geq$ 5 in d.b.h. per acre and consists predominantly of grand fir and Douglas-fir.

No pre-treatment population or defoliation estimates were made in the control block, because the control block was not established until after the treatments had been imposed. Post-treatment population and defoliation estimates were similar to those recorded for other treatment units. Post-treatment larval populations averaged 10.44, 0.68, and 0.47 larvae per 1,000 in^2 of foliage in 1987, 1988, and 1989, respectively (Tables 5 and 6).

DISCUSSION

In 1984, when the various silvicultural treatments were imposed, the budworm outbreak was in its fourteenth year of a 17-year outbreak. Pre-treatment budworm populations (1983) ranged from 7.04 larvae per 1,000 in^2 of foliage in the seed tree unit to 12.08 larvae per 1,000 in^2 of foliage in the clear-cut and plant unit. After treatment in units which retained more than 70 ft^2 of basal area in grand fir, larval populations did not appear to change as a result of the treatments (i.e. commercial thin—unit 4, control unit). However, in units featuring ponderosa pine and Douglas-fir with only minor amounts of grand fir, populations appeared to be considerably lower (i.e. seed tree—unit 5, shelterwood—unit 14) after the silvicultural treatments had been completed. Grand fir supported higher population levels and, therefore, sustained higher levels of defoliation both prior to treatment and after treatment than did Douglas-fir. Defoliation levels were 3 to 4 times higher on grand fir than on Douglas-fir until the population collapsed. Between June 1987 and June 1988, larval populations in all treatment units and throughout susceptible stands on the Payette NF declined dramatically. Therefore, differences between larval populations in the various units could not be detected in samples taken in 1988 and 1989.

After treatment, changes in the overall stand growth rates, expressed as cubic ft volume per tree per year, seemed to be directly related to changes in stocking levels of the various species. Pre-treatment stand growth rates were .40, .40, .55, and .88 cubic ft volume per tree per year in the clear-cut and plant unit, the commercial thin unit, the seed tree unit, and the shelterwood unit, respectively (Table 1). Stand growth rates 5 years after treating averaged .45, 1.57, and 1.10 cubic ft volume per tree per year in the commercial thin unit, the seed tree unit, and the shelterwood unit, respectively. In units where grand fir stocking was reduced to less than a fourth of the total stocking (i.e. seed tree unit, shelterwood unit), stand growth rates increased. But, where the majority of the stems after treating were grand fir (i.e. commercial thin unit), the stand growth rate remained relatively low and stable.

A closer examination of the growth rates by species (Table 7) indicate that rates established from measurements taken during a 10-year period (1974 to 1983) before treatment were similar to growth rates estimated from measurements taken during a 5-year period (1985 to 1989) after treatment. Only ponderosa pine showed a consistent growth increase after treatment; however, the sample size was too small to draw any firm conclusions.

Several factors confound the interpretation of these data. Budworm populations which had been present in the area for approximately 14 years prior to treatment collapsed in 1987. Therefore, all host species had been partially defoliated repeatedly for 17 years. Ponderosa pine, the only non-host species found in the area, was not defoliated during this time. Even without defoliation, ponderosa pine was not outgrowing Douglas-fir or grand fir on these sites. This may indicate that other factors were limiting the growth potential of these sites. Stocking and consequently competition for some limiting resource, i.e. water, could explain the similar growth rates between non-defoliated non-host trees and defoliated host trees. After treatment, when stocking was reduced, ponderosa pine grew more rapidly than Douglas-fir and grand fir. Overall growth rates for both Douglas-fir and grand fir decreased or remained relatively low after treatment which was probably a result of continuing defoliation and the occurrence of a 5-year drought period. Grand fir, which has greater moisture requirements than either Douglas-fir or ponderosa pine and which was more heavily defoliated throughout the infestation, would be expected to grow at a retarded rate. The trend seen in these data is for grand fir to grow slower than Douglas-fir and ponderosa pine even in the units which had received silvicultural manipulation.

The data collected from this demonstration area support the premise that silvicultural methods/treatments on grand fir sites can reduce budworm population levels when non-host or less preferred hosts are featured. However, the impact of this budworm population reduction on timber growth is not clear.

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Table 1.--Pre-treatment stocking levels (number of trees/AC), basal area (ft^2), and volumes (MBF) by species for green trees $\geq$ 5 in d.b.h. growing within the WSBW silvicultural treatment units, Payette National Forest.

Treatment areas	size (AC)		Total	GF	DF	PP	ES	WL	LP
Commercial Thin	15								
Unit 4		No. trees/AC	306	287	8	1	10	0	0
		Basal area (ft^2)	186	156	18	2	10	0	0
		Volume (MBF)	20.0	16.1	2.4	0.0	1.5	0.0	0.0
Seed Tree	26								
Unit 5		No. trees/AC	136	78	35	15	3	0	5
		Basal area (ft^2)	118	52	54	6	4	0	2
		Volume (MBF)	15.5	6.2	8.5	0.1	0.5	0.0	0.2
Shelterwood	15								
Unit 14		No. trees/AC	60	14	26	20	0	0	0
		Basal area (ft^2)	122	18	68	36	0	0	0
		Volume (MBF)	15.5	3.6	11.1	0.6	0.0	0.0	0.0
Clear-cut & Plant	13								
Unit 26		No. trees/AC	179	149	23	5	3	1	0
		Basal area (ft^2)	130	70	48	8	2	2	0
		Volume (MBF)	14.4	6.7	7.1	0.1	0.1	0.4	0.0
Control	10								
		No. trees/AC	181	148	28	5	0	0	0
		Basal area (ft^2)	158	102	50	6	0	0	0
		Volume (MBF)	22.2	13.6	8.5	0.1	0.0	0.0	0.0

Table 2.--Post-treatment stocking levels (number of trees/AC), basal area (ft^2/AC), volumes removed (MBF/AC), and volumes remaining (MBF/AC) by species for green trees $\geq$ 5 in d.b.h. growing within the WSBW silvicultural treatment units, Payette National Forest (1985).

Treatment areas	size (AC)		Total	GF	DF	PP	ES	WL	LP
Commercial Thin	15								
Unit 4		No. trees/AC	95	85	3	0	8	0	0
		Basal area (ft^2)	82	72	2	0	8	0	0
		Volume 1 (MBF)[a]	8.5	6.0	2.2	0.0	0.3	0.0	0.0
		Volume 2 (MBF)[b]	11.5	10.1	0.2	0.0	1.2	0.0	0.0
Seed Tree	26								
Unit 5		No. trees/AC	21	0	6	15	0	0	0
		Basal area (ft^2)	22	0	18	4	0	0	0
		Volume 1 (MBF)	12.0	6.2	5.0	0.1	0.5	0.0	0.2
		Volume 2 (MBF)	3.5	0.0	3.5	0.0	0.0	0.0	0.0
Shelterwood	15								
Unit 14		No. trees/AC	40	10	16	14	0	0	0
		Basal area (ft^2)	68	6	42	20	0	0	0
		Volume 1 (MBF)	7.3	2.8	4.2	0.3	0.0	0.0	0.0
		Volume 2 (MBF)	8.0	0.8	6.9	0.3	0.0	0.0	0.0
Clear-cut & Plant	13								
Unit 26		No. trees/AC	0	0	0	0	0	0	0
		Basal area (ft^2)	0	0	0	0	0	0	0
		Volume 1 (MBF)	14.4	6.7	7.1	0.1	0.1	0.4	0.0
		Volume 2 (MBF)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control	10								
		No. trees/AC	181	148	28	5	0	0	0
		Basal area (ft^2)	158	102	50	6	0	0	0
		Volume 1 (MBF)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Volume 2 (MBF)	22.2	13.6	8.5	0.1	0.0	0.0	0.0

[a] Volume 1 (MBF) = green volume/AC removed
[b] Volume 2 (MBF) = green volume/AC remaining after harvest

Table 3.--Pre-treatment and post-treatment stocking levels (number of trees/AC) by species for green trees < 5 in d.b.h. growing within the WSBW silvicultural treatment units, Payette National Forest.

Treatment areas	size (AC)		Trees per acre						
			Total	GF	DF	PP	ES	WL	LP
Commercial Thin	15								
Unit 4		Pre	20	20	0	0	0	0	0
		Post	0	0	0	0	0	0	0
Seed Tree	26								
Unit 5		Pre	360	300	60	0	0	0	0
		Post	600	30	150	420	0	0	0
Shelterwood	15								
Unit 14		Pre	660	410	150	100	0	0	0
		Post	540	450	30	60	0	0	0
Clear-cut & Plant	13								
Unit 26		Pre	200	180	20	0	0	0	0
		Post	430	0	220	100	0	110	0
Control	10								
		Pre	200	180	20	0	0	0	0
		Post	1140	900	240	0	0	0	0

Table 4.--Pre-treatment (1983) mean larval densities per 1,000 in^2 of foliage on host species within the WSBW silvicultural treatment units, Payette National Forest.

Treatment areas		Mean No. larvae per 1,000 in^2		
		GF	DF	ES
Commercial Thin	$\underline{n}$	7	3	0
Unit 4	$\bar{x}$	9.75	2.43	-
	s	7.28	1.14	-
Seed Tree	$\underline{n}$	5	3	2
Unit 5	$\bar{x}$	8.19	3.45	9.54
	s	8.26	1.77	0.34
Shelterwood	$\underline{n}$	6	4	0
Unit 14	$\bar{x}$	14.43	4.32	-
	s	4.65	3.10	-
Clear-cut & Plant	$\underline{n}$	7	3	0
	$\bar{x}$	14.89	5.39	-
	s	4.92	1.23	-
Control	$\underline{n}$	-	-	-
	$\bar{x}$	-	-	-
	s	-	-	-
Mean	$\bar{x}$	11.81	3.90	9.54
	s	3.35	1.26	-

Table 5.--Mean larval densities per 1,000 in^2 on host species within the WSBW silvicultural treatment units, Payette National Forest.

Treatment areas		Mean No. larvae per 1,000 in^2 1983	1987	1988	1989
Commercial Thin	$\underline{n}$	10	50	50	50
Unit 4	$\bar{x}$	7.55	10.43	1.56	0.79
	s	6.94	6.28	2.52	1.43
Seed Tree	$\underline{n}$	10	20	50	50
Unit 5	$\bar{x}$	7.04	0.46	0.33	0.26
	s	6.12	1.10	0.92	0.92
Shelterwood	$\underline{n}$	10	50	50	50
Unit 14	$\bar{x}$	10.38	4.40	0.39	0.26
	s	6.52	4.10	0.75	0.70
Clear-cut & Plant	$\underline{n}$	10	-	-	-
	$\bar{x}$	12.08	-	-	-
	s	6.08	-	-	-
Control	$\underline{n}$	-	50	50	50
	$\bar{x}$	-	10.44	0.68	0.47
	s	-	10.19	1.92	0.89
Mean	$\bar{x}$	9.26	6.43	0.74	0.45
	s	2.38	4.90	0.57	0.25

Table 6.--Mean percent defoliation calculated from whole tree estimates of percent defoliation on host species within the WSBW silvicultural treatment areas, Payette National Forest.

Treatment areas	species	mean percent defoliation 1983 [a]	1985 [b]	1986 [b]
Commercial Thin	DF	20.83	57.67	15.0 [c]
Unit 4	GF	69.64	-	96.95
	ES	-	-	21.25
Seed Tree	DF	20.83	33.83	30.56
Unit 5	GF	72.50	-	-
	ES	12.50	-	-
Shelterwood	DF	25.00	45.00	19.05
Unit 14	GF	66.67	-	83.33
	ES	-	-	-
Clear-cut & Plant	DF	12.50	-	-
Unit 26	GF	76.79	-	-
	ES	-	-	-
Control	DF	-	61.92	23.93
	GF	-	-	95.93
	ES	-	-	-
Mean	DF	19.79	49.61	22.14
	GF	71.40	-	92.07
	ES	12.50	-	21.25

[a] Pre-treatment
[b] Post-treatment
[c] N = 1

Table 7.--Mean pre- and post-treatment growth rates (cubic ft volume/tree/year) for combined species and mean individual growth rates (radial growth in inches/5 years) by species for green trees ≥ 5 in d.b.h. growing within the WSBW silvicultural treatment units, Payette National Forest.

Treatment areas	size (AC)		Total	GF	DF	PP
Commercial Thin	15					
Unit 4		Pre-treatment				
		Growth rate	0.40[a]	0.21[b]	0.52	0.08
		Trees/Ac	340.4	321.5	18.3	0.5
		Post-treatment				
		Growth rate	0.45	0.19	0.57	-
		Trees/AC	93.5	91.6	1.9	-
Seed Tree	26					
Unit 5		Pre-treatment				
		Growth rate	0.55	0.27	0.30	0.14
		Trees/Ac	136.6	77.9	35.3	14.9
		Post-treatment				
		Growth rate	1.57	-	0.26	0.36
		Trees/AC	6.3	-	5.9	0.4
Shelterwood	15					
Unit 14		Pre-treatment				
		Growth rate	0.88	0.33	0.36	0.26
		Trees/Ac	59.4	13.5	25.7	20.2
		Post-treatment				
		Growth rate	1.10	0.33	0.32	0.35
		Trees/AC	30.4	7.6	16.5	6.2
Clear-cut & Plant	13					
Unit 26		Pre-treatment				
		Growth rate	0.40	0.23	0.36	0.25
		Trees/Ac	179.5	148.5	22.8	4.7
		Post treatment				
		Growth rate	-	-	-	-
		Trees/AC	-	-	-	-
Control	10					
		Pre-treatment				
		Growth rate	-	-	-	-
		Trees/Ac	-	-	-	-
		Post-treatment				
		Growth rate	0.53	0.16	0.26	0.51
		Trees/AC	171.6	143.8	23.5	4.3

[a] Mean growth rate for combined species expressed as cubic foot volume per tree per year.
[b] Mean growth rate by species expressed as radial growth in inches during 5 years.

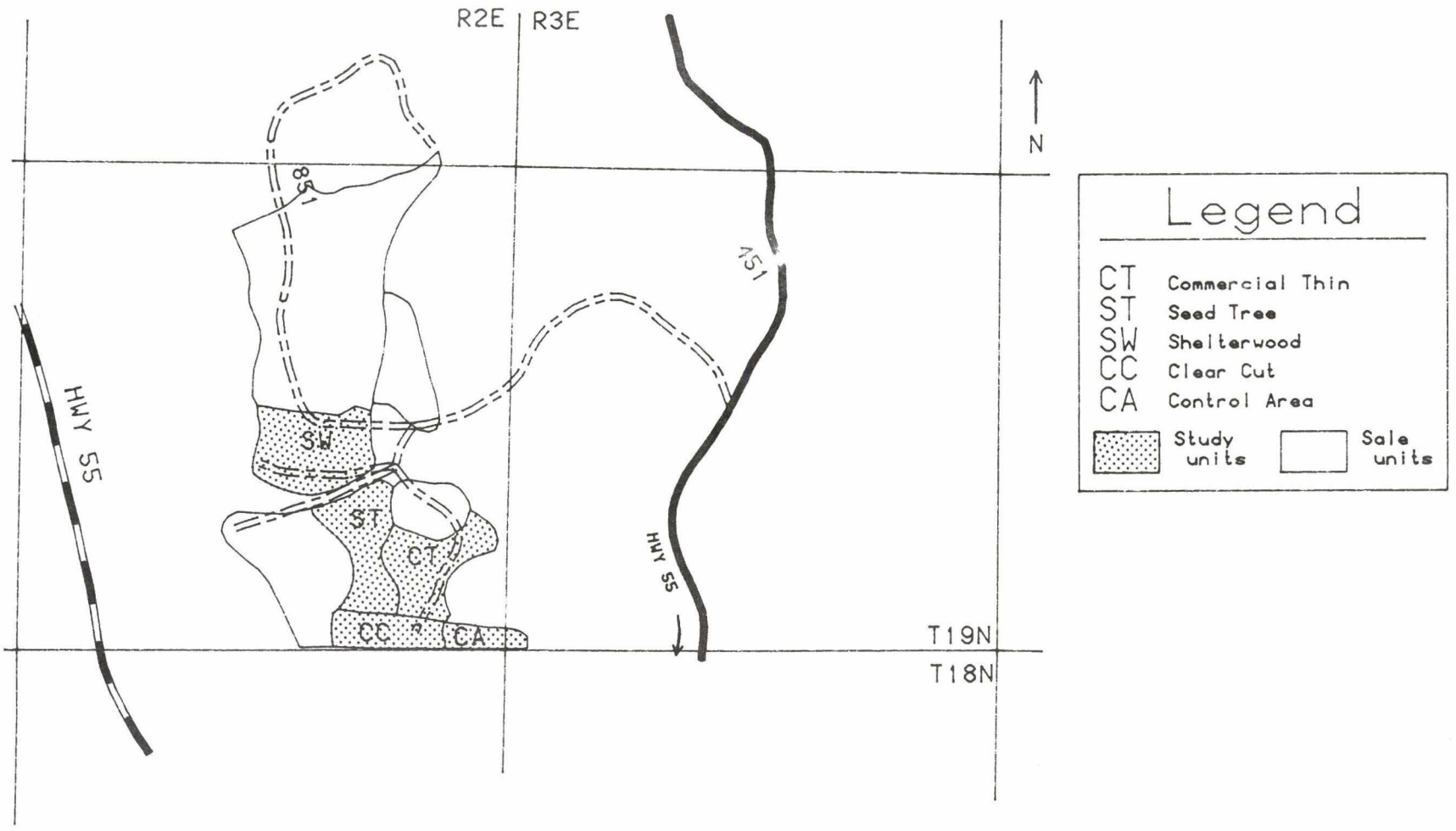

Figure 1.–Western spruce budworm silvicultural demonstration area, Payette National Forest.